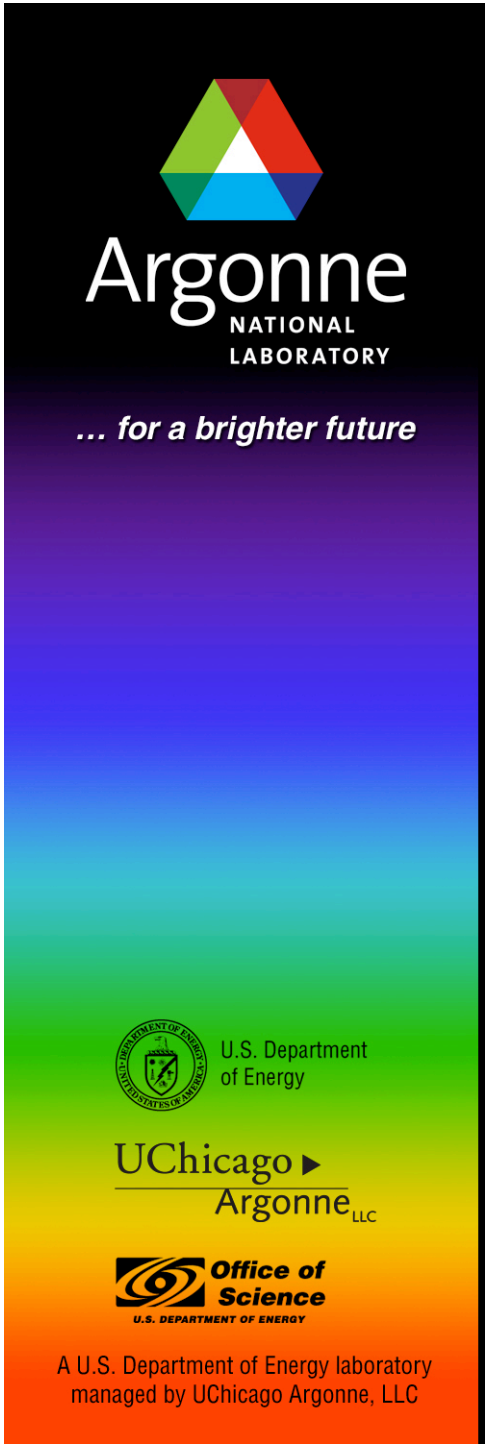
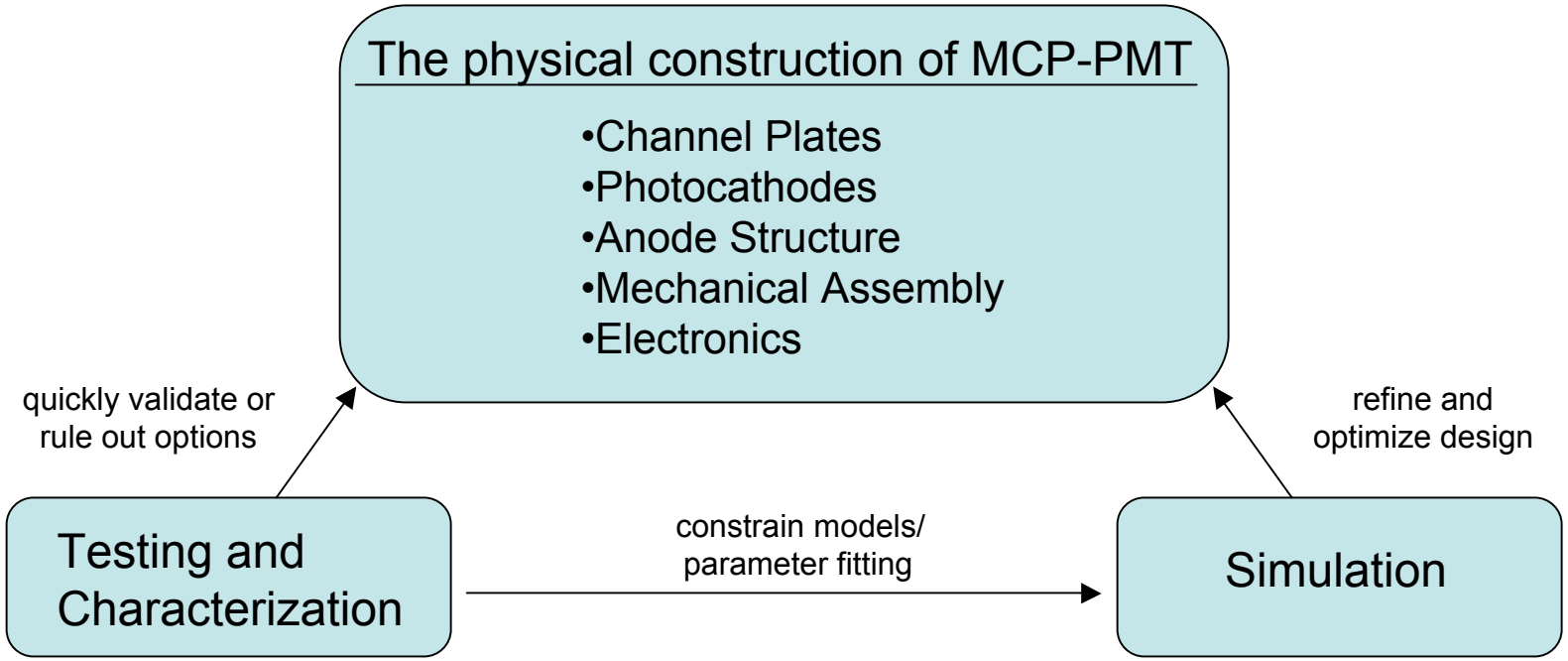


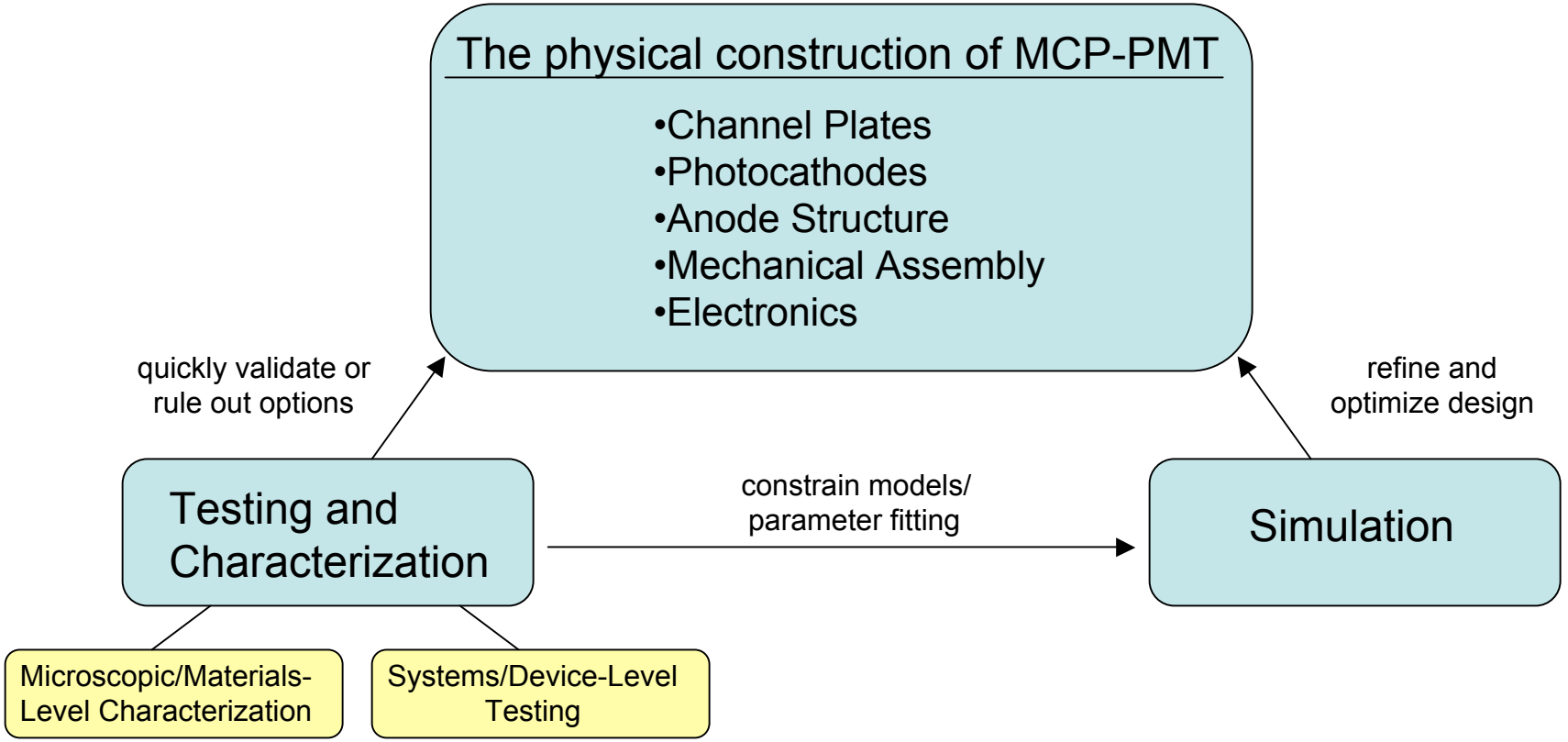
Channel Plate Testing and Systems Integration At the Advanced Photon Source

Microchannel Plate group, LAPPD Collaboration

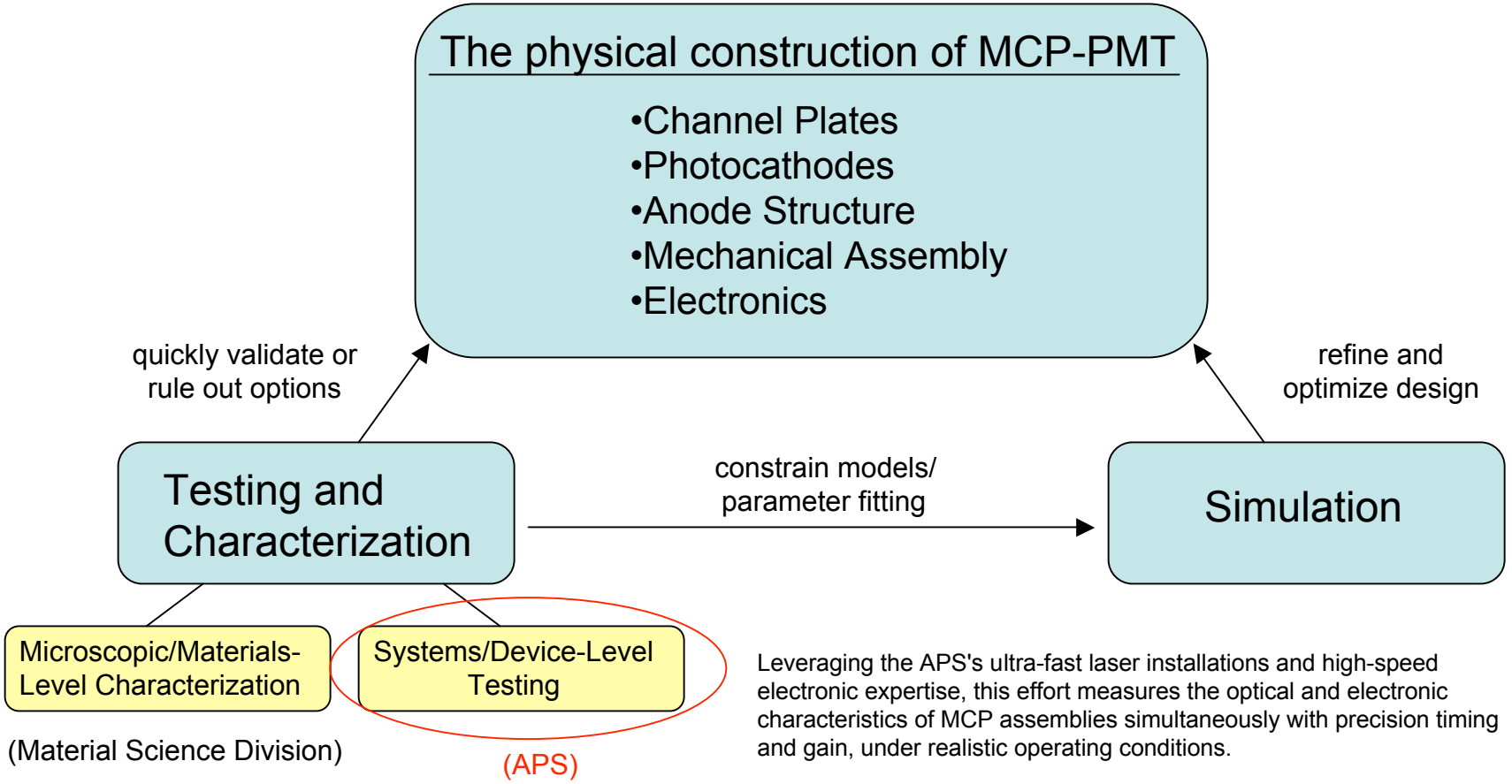
Goals of the APS Test Stand



Goals of the APS Test Stand



Goals of the APS Test Stand



Leveraging the APS's ultra-fast laser installations and high-speed electronic expertise, this effort measures the optical and electronic characteristics of MCP assemblies simultaneously with precision timing and gain, under realistic operating conditions.

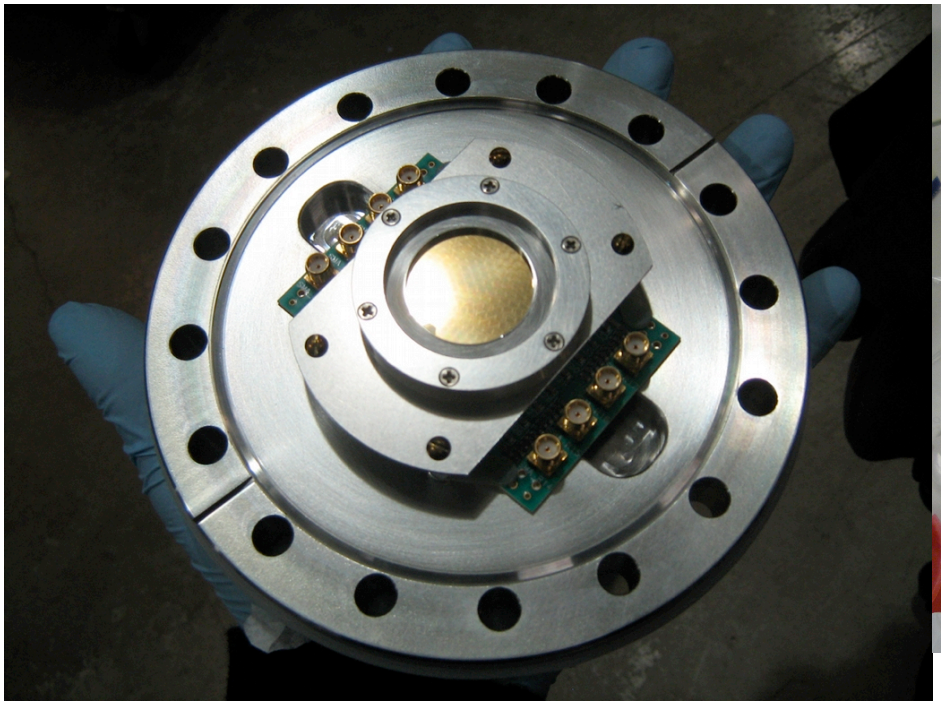
Goals and Capabilities

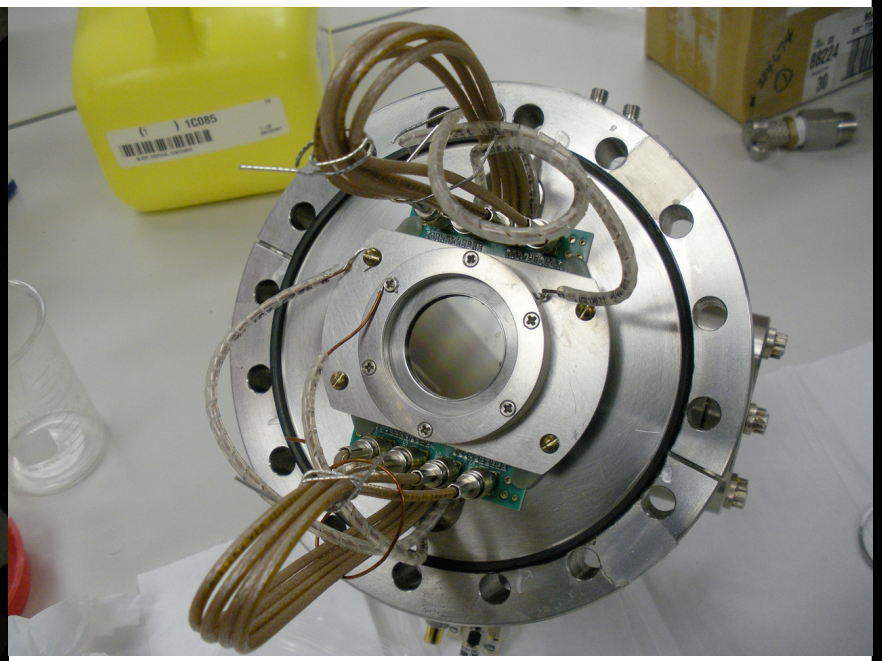
- Develop Operational Experience
  - •Working with ALD functionalized MCPs
  - •Working with stripline anode structure similar to final product
- Figure out what MCP recipes work (and don't work)
- Basic MCP characterization for Chevron pairs
  - •Photon counting, pulse height distributions, amplification curves
  - •Image profile, position resolution, signal shape, uniformity
  - •I/V curves, dark current, technical issues
- Advanced Characterization in the time domain
  - •Transit time spread, arrival time, first strike problem
- Full sized testing

What we don't focus so much on…

- Single plate characterization (we're in photon counting, ie saturation mode)
- Current based measurements
- Fundamental material-level analysis (well, maybe some…)
- Lots of fine variations in samples (turn-over too slow)

Setup

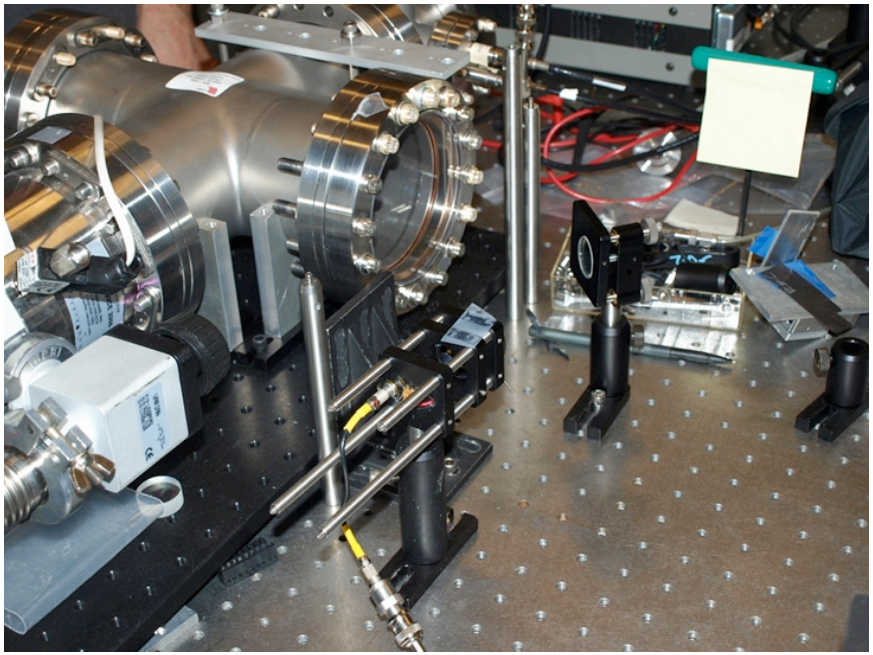


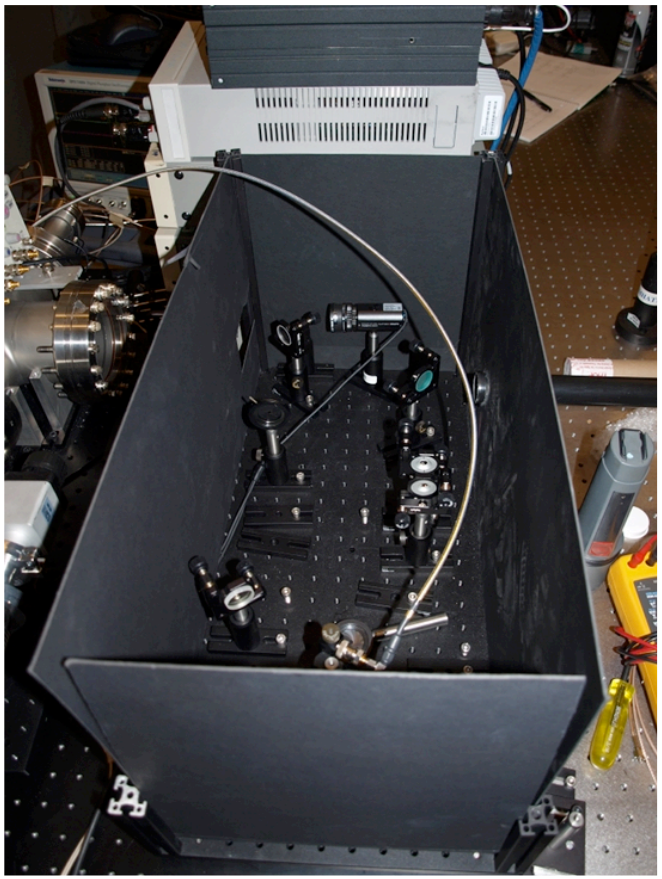


- Mobile experimental table
- 4-vacuum cross w/ large turbo pump, ion guage, window
- Compact, removable flange with sample holder, anode board, SMA/HV feedthroughs

Setup

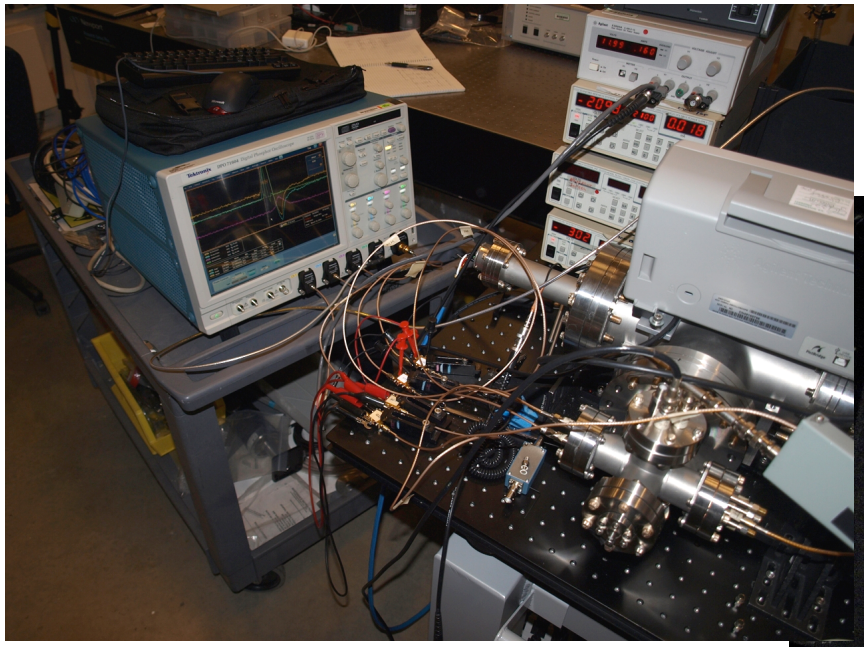
- Ultra-fast (femto-second pulses, few thousand Hz) Ti-Sapphire laser, 800 nm, frequency triple to 266 nm
- Small UV LED
- Modular breadboards with laser/LED optics





Setup

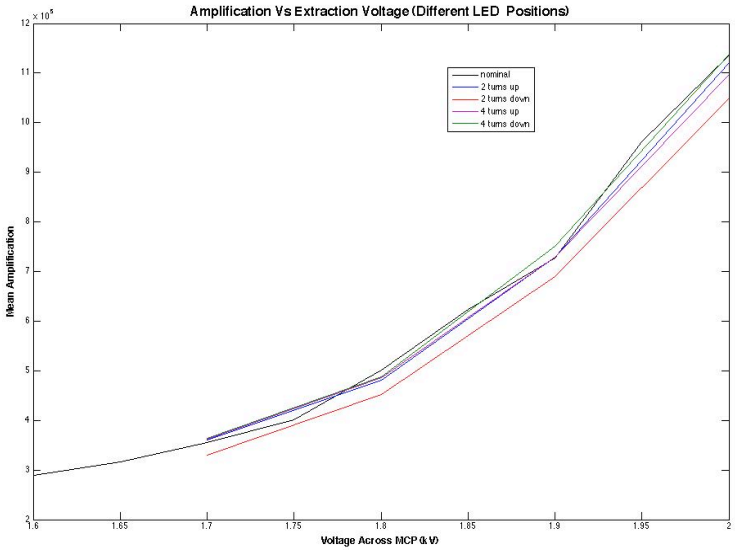
- Ultrafast electronics: scopes, amplifiers cabling



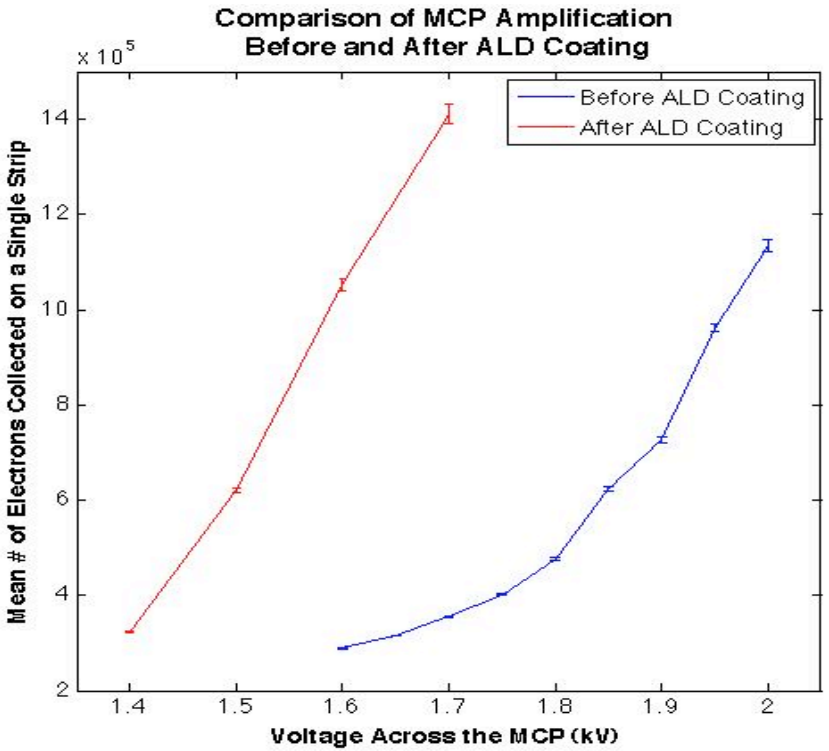
Accomplishments

- A working characterization system from nothing.
- Developed methodology for LED and laser based MCP measurements
- Demonstration of enhanced amplification with high SEE ALD coating on commercial MCP.
- First measurements of a working Argonne MCP pair.
- Stronger collaboration with fabrication, simulation, and testing groups.
- Faster turn-around and feedback.

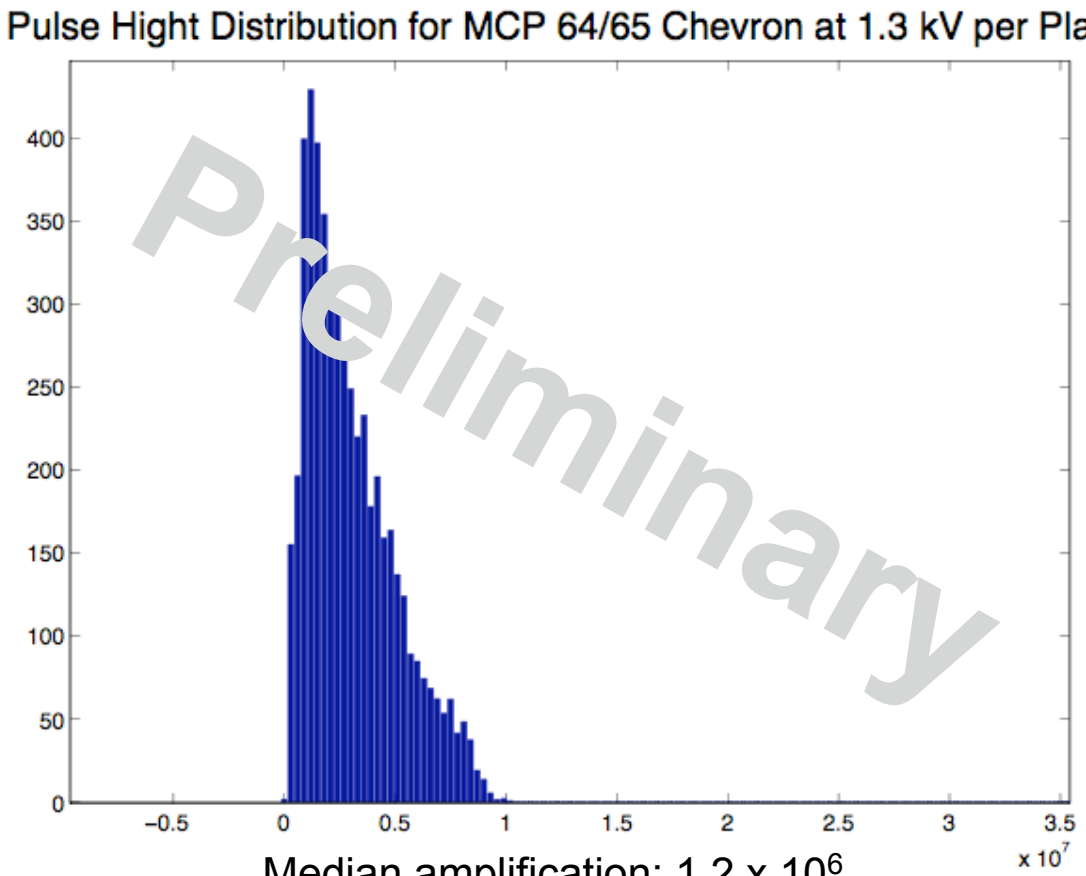
Accomplishments: SEE Enhancement



- After characterizing the Photonis MCP, we coat the plates with 10 nm Al_2O_3.
- The "after-ALD" measurements have been taken without scrubbing.
- These measurements are ongoing.



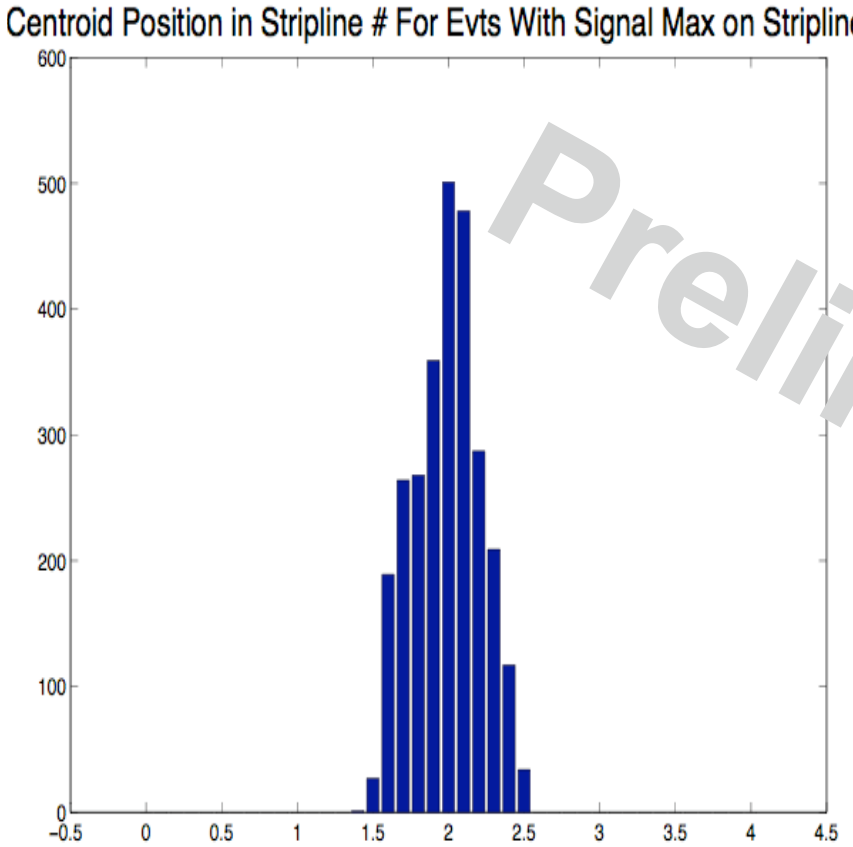
Accomplishments: MCP 64/65

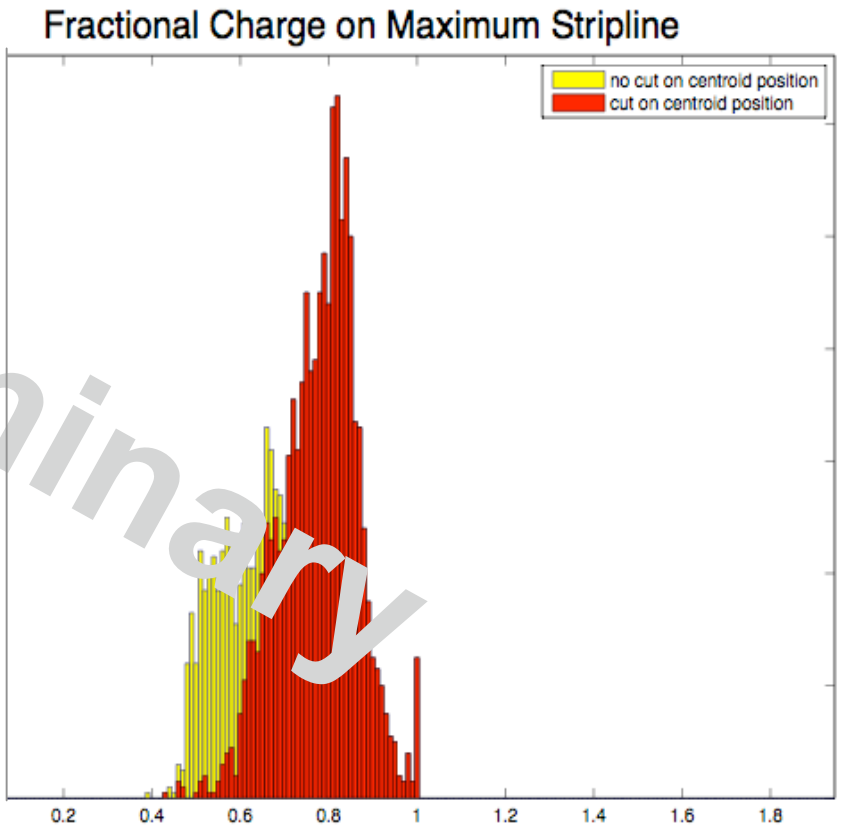


Median amplification: 1.2 x 10^6

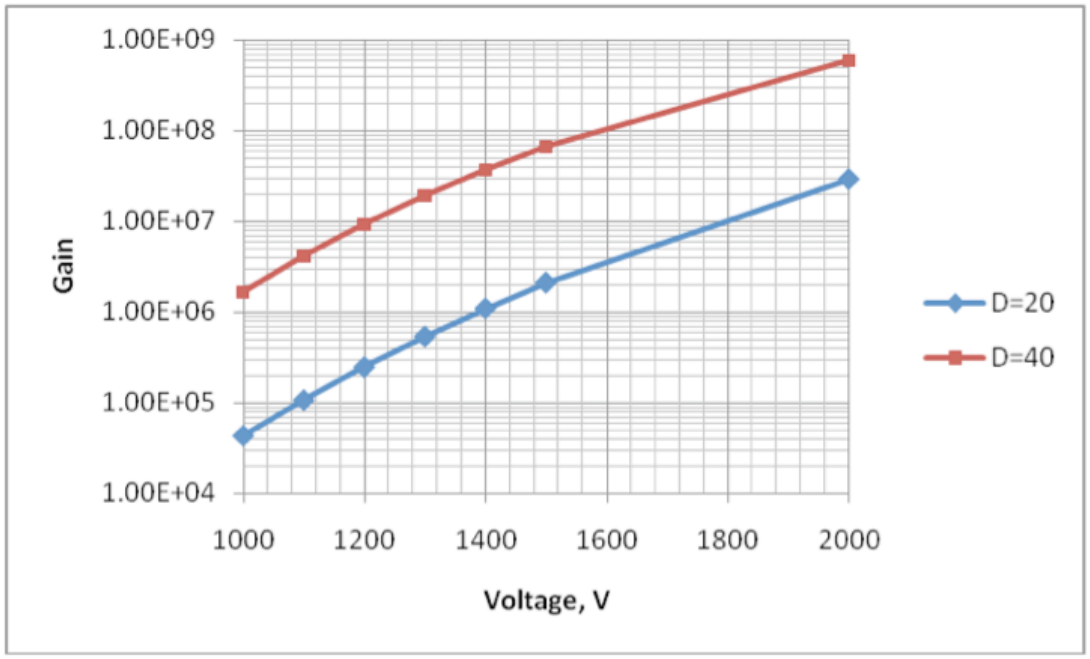
Mean amplification: 5.7 x 10^6

Accomplishments: MCP 64/65





Accomplishments: MCP 64/65



Gain vs. MCP voltage. Blue – D=20um, L/D=60; Brown – D=40um, L/D=40.

Pore coating Al2O3, Sigma_max=6.23, Umax=550V.

Technical Lessons Learned

- Proper handling and assembly of MCPs
- Methodology for single PE mode with laser and LED
- Sparking
  - Avoidance
    - Proper electrode coating
    - Avoiding edge effects
    - Avoiding inappropriate materials (like solder)
    - Staying comfortably below 3 kV
    - Don't reuse plates that have already sparked (new)
  - Protection
    - Load resistor or inductor in series with HV (reduce spark magnitude)
    - When possible, pulsed HV
    - Sacrificial amps
    - Slow ramp up with pauses
    - Discipline in unplugging SMA cables

Turnover

- 1 hour, sample preparation
- 3-4 hours pump down
- 2.5 hours to do measurement
- 1-2 hours offline analysis, proofreading

Turnover

- 1 hour, sample preparation
- 3-4 hours pump down
  - this will improve with better vacuum compatibility
- 2.5 hours to do measurement
  - Automation will greatly trim this down
- 1-2 hours offline analysis, proofreading
  - Can be done while pumping-down next sample

Turnover

- 1 hour, sample preparation
- 3-4 hours pump down
  - this will improve with better vacuum compatibility
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- 1-2 hours offline analysis, proofreading
  - Can be done while pumping-down next sample

Right now, we're looking at about a day per sample… Eventually we can get that down to 2 samples a day…Undergrad labor might help?

MCP Lessons Learned

- A 50 MΩ resistive coating, using Anil's chemistry, with Al_2O_3 works!
- Lower resistances (20 MΩ) might have thermal runaway problems.
- MgO SEE coating seems to be field emitting (high dark current rates)
- Some difficulties with very high resistances (saturation?)

Next Steps: Short Term (now-June)

- Press ahead on basic ALD tests, refine questions/reduce phase space
  - Can we make MgO work?
  - Comparisons of various resistances…
  - Electrode on top vs. bottom?
  - Qing's vs Anil's chemistry?
  - Verify geometric dependences (40 vs 20 microns, spacing…)
  - Baseline comparison with commercial pair
  - Annealing?
  - Scrubbing?
- Work on readying full B-flange setup

Next Steps: Specific tests

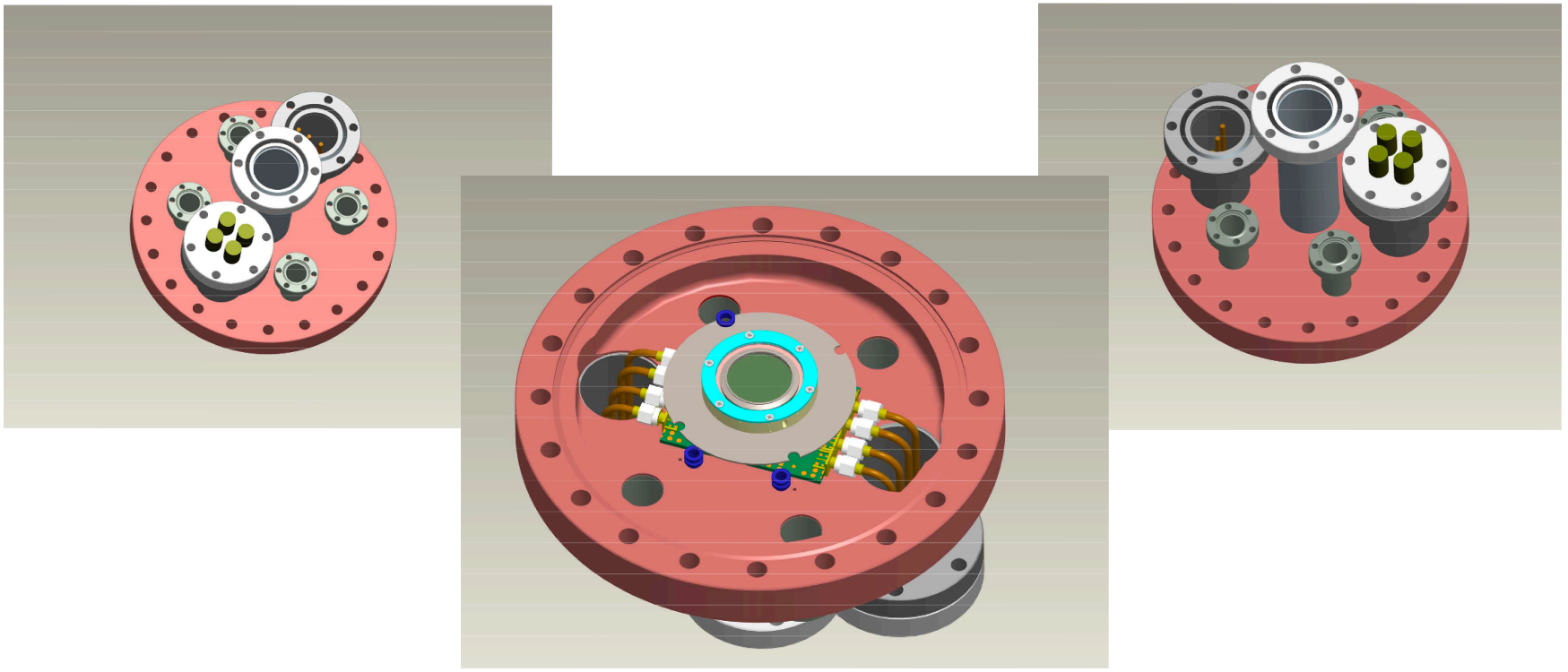
- 3 plates with identical 50 MΩ resistive coating (Anil's), two with Al_2O_3 SEE coating, one with MgO.
  - Re-measure Al_2O_3 pair, swap MgO plate with top/bottom plate
- Swap in one identical plate with electrode coating *under* ALD. Test a pair (when photocathode is available)
- Two Variations in thicknesses of SEE coating/resistive coating
- Redo commercial tests as baseline.
- Reexamine, low resistance plates, identical to working 50 MΩ plates. Still runaway currents? of higher resistance plates.

Next Steps: Questions for other groups

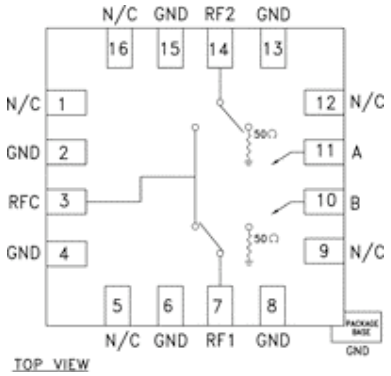
- Simulations on the effect of gaps (simulation group)
- Sensitivity to secondary emissivity (simulation group)
- Failure analysis of broken MCPs (ALD group)
- Thermal coefficient of resistivity tests (with cooling and heating), before and after annealing (ALD group)
- Better understanding of SEE properties (materials characterization group)
- Morphology questions (?)

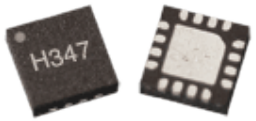
Next Steps: Medium Term (summer+)

- Completed B-Flange



Next Steps: Medium Term



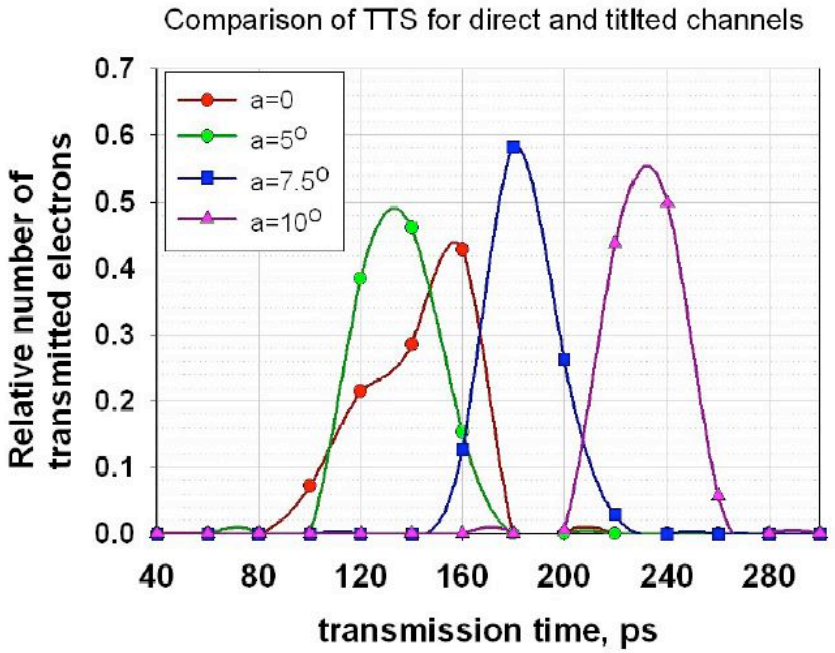


- Automation…
  - –Motorized mirror mounts
  - –Computerized scope acquisition
  - –Relaying between input channels
  - –Computer controlled HV
  - –Tying it all together (labview?)

Next Steps: Medium Term

- Laser timing measurements

Transit Time Spread (TTS)



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V. Ivanov (Muons,Inc), A. Tremsin (SSL/Arradiance),
N. Sullivan (Arradiance)

Remaining Technical Issues/Work

- Making a photocathode
- Spacing the MCPs
- Rigid, vacuum compatible SMAs
- Automating the measurement process
- Completion of the B-flange

Next Steps: Long Term (year 2+)

- 8” x 8” testing, pseudo-complete glass(?) assembly, welded onto a large flange
- Readout all channels using LAPPD-designed electronics
- For quality control and to test data acquisition methods

Conclusions

- We have successfully assembled the right resources, man-power, expertise, and experience necessary to meet our testing goals.
- Some early successes are encouraging.
- We're just about over the hump - starting to move quickly on finding working recipes, have some good leads…
- Now is a critical time.
- In the near future, we hope to have publishable results.